Space Weather Technical Forecast

Issued on Tuesday, 14 November 2023 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares, risk declining through the period. Slight Chance of a G1/Minor Geomagnetic Storm on Day 2 (15 Nov). Chance of Active fluence throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours with occasional C-class flares and a peak flare of C2.8 at 13/2050 UTC from AR3484 in the southwest. There are currently five sunspot regions on the visible disc, all of which lie in the west. The eastern disc has several plage areas, although no sunspots are currently evident. The largest region is AR3483, close to the northwestern limb. The other regions have all shown recent signs of growth and have increased in magnetic complexity. AR3487 in the southwest has emerged through the 13 Nov, and is currently one of the more unstable regions with regards to flare probabilities.

No Earth-directed CMEs have been observed on available imagery over the past 24 hours.

Solar Wind / Geomagnetic Activity:

Solar winds, as observed at L1 by ACE and DSCOVR, have predominantly remained at slightly elevated levels between 400-450 km/s having initially been on a slightly declining trend. Density was above average until around 13/1500 UTC, peaking at 38pccc. It has since fluctuated between average and below average levels. The total magnetic field strength (Bt) has been largely moderate but fell weak for a time between 13/0730-1500 UTC. The north-south component (Bz) was weakly negative until 13/0200 and has since remained mainly weak and positive. From around 13/1500 UTC Bz has become more moderate, with a range of -9nT/+14nT through the past 24 hours. The phi angle has been mostly positive (away from Earth). Geomagnetic activity has been Quiet to Unsettled (Kp 0-3), but with a G1/Minor Geomagnetic Storm (Kp 5) interval at 13/0000-0300 UTC following a period of negative Bz.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was initially at moderate levels, peaking at 3920pfu at 13/0105 UTC, but dropped to background levels around 13/0200 UTC and remained as such other than a brief diurnal peak at moderate levels. The associated 24-hour fluence was above the Active (1e8 integrated pfu) threshold but fell below Active by 13/0600 UTC and has remained on a steeply declining trend. The fluence observation at 14/0000UTC was 3.71e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain at Low levels, with a chance of M-class flares, mainly Days 1-2 (14-15 Nov). The probability of M-flares declines by Day 3 (16 Nov) as sunspot regions rotate off of the disc. No significant new or returning regions are expected to rotate onto the visible disc during the next four days.

Solar Wind / Geomagnetic Activity: A faint and slow CME was observed leaving the Sun late on 10 Nov which may give Earth a glancing blow on Day 2 (15 Nov). Solar winds are expected

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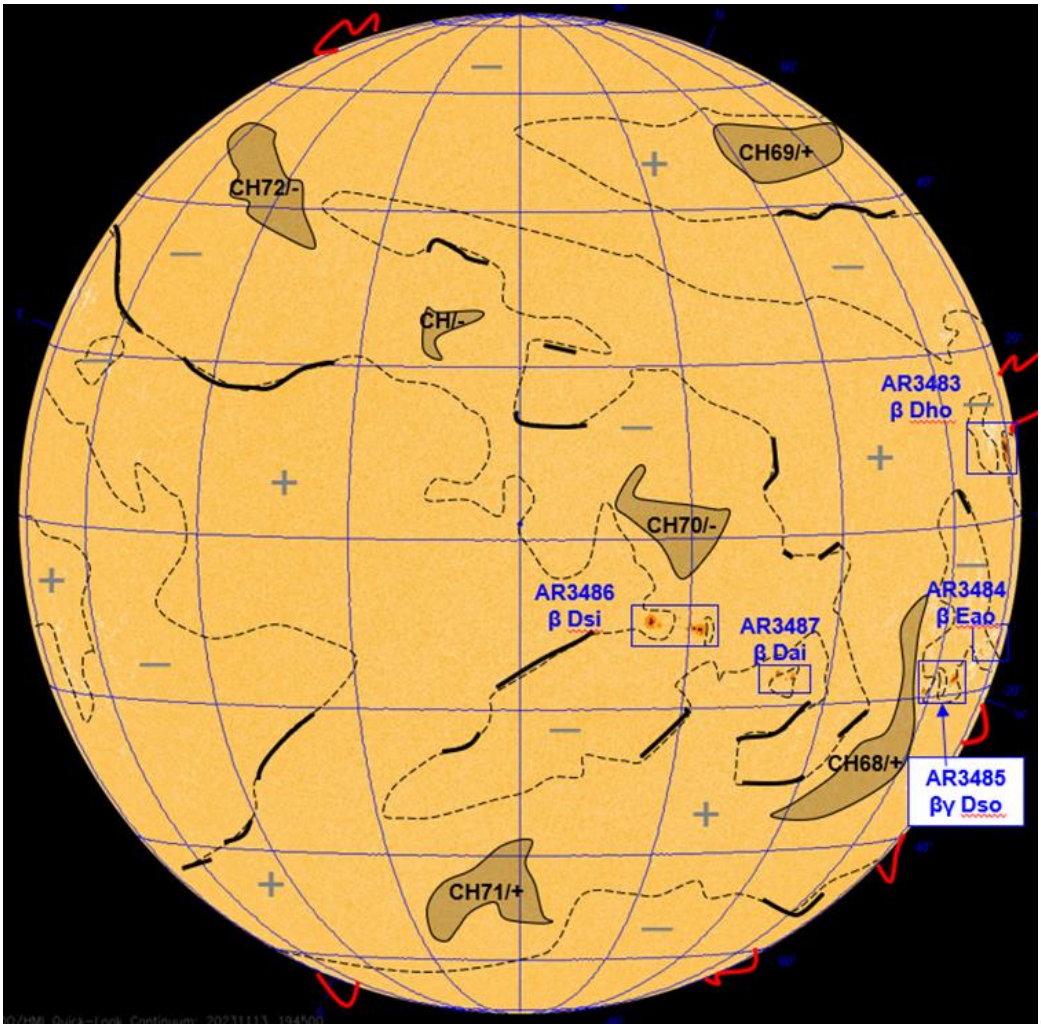
to decline to slow-ambient levels through Day 1 (14 Nov), but may see some enhancements Days 2-3 (15-16 Nov) due to a combination of weak effects from fast winds from CH70/- and the possible CME arrival.

Largely Quiet to Unsettled (Kp 0-3) geomagnetic activity expected. Chance of Active (Kp 4) intervals and a slight chance of an isolated G1/Minor Geomagnetic Storm (Kp 5) on Day 2 (15 Nov) due to the potential combination of weak enhancements from a coronal hole and possible CME arrival.

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor Radiation Storm conditions during the period should any sunspot regions produce significant flares. Probabilities begin to wane later in the period as these regions rotate well beyond the western limb.
The electron flux is now currently at background levels. There is low confidence in the behaviour of the electron flux in the coming days, but a recovery in values is expected with a chance of diurnal periods of high flux. There is a chance that electron fluence may increase again over the coming days, perhaps returning to Active levels. Low confidence in the arrival and effects of any geomagnetic activity is reflected by low confidence in electron response.

Figure 1. Solar Analysis Valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A slow CME observed leaving the Sun around 10/1930 UTC may give a glancing blow on Day 2 (15 Nov). However, MOSWOC Enlil modelling would suggest that the bulk of the CME will miss ahead. The source region of this CME appears to be an eruption following a dimming event and flare from the southwest quadrant in the vicinity of AR3484 and AR3485. Slight impacts are possible in association with this low probability potential arrival. No other Earth-directed CMEs are in the current forecast.

Current solar wind speeds are around 400-430 km/s, and may be exhibiting signs of slight enhancement from CH68/+ in the southwest. Any influence from this is expected to wane through Day 1 (14 Nov) with winds expected to fall to slow-ambient levels. A further small coronal hole, CH70/-, is currently near centre disc. This may cause a slight enhancement to solar winds on Days 2-3 (15-16 Nov), with the HSS perhaps coinciding with, or masking the arrival of, the glancing CME.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3). On Day 2 (15 Nov), activity may become Unsettled (Kp 3), with a chance of Active (Kp 4) intervals and a slight chance of an isolated G1/Minor Geomagnetic Storm (Kp 5) due to the potential combination of weak enhancements from a CME arrival and any HSS from CH70/-.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0633	Partial	Dimming event / partial filament	SW disc near AR3484	378 km/s	15/1800 +/- 12 hours	Glancing blow. Low confidence.

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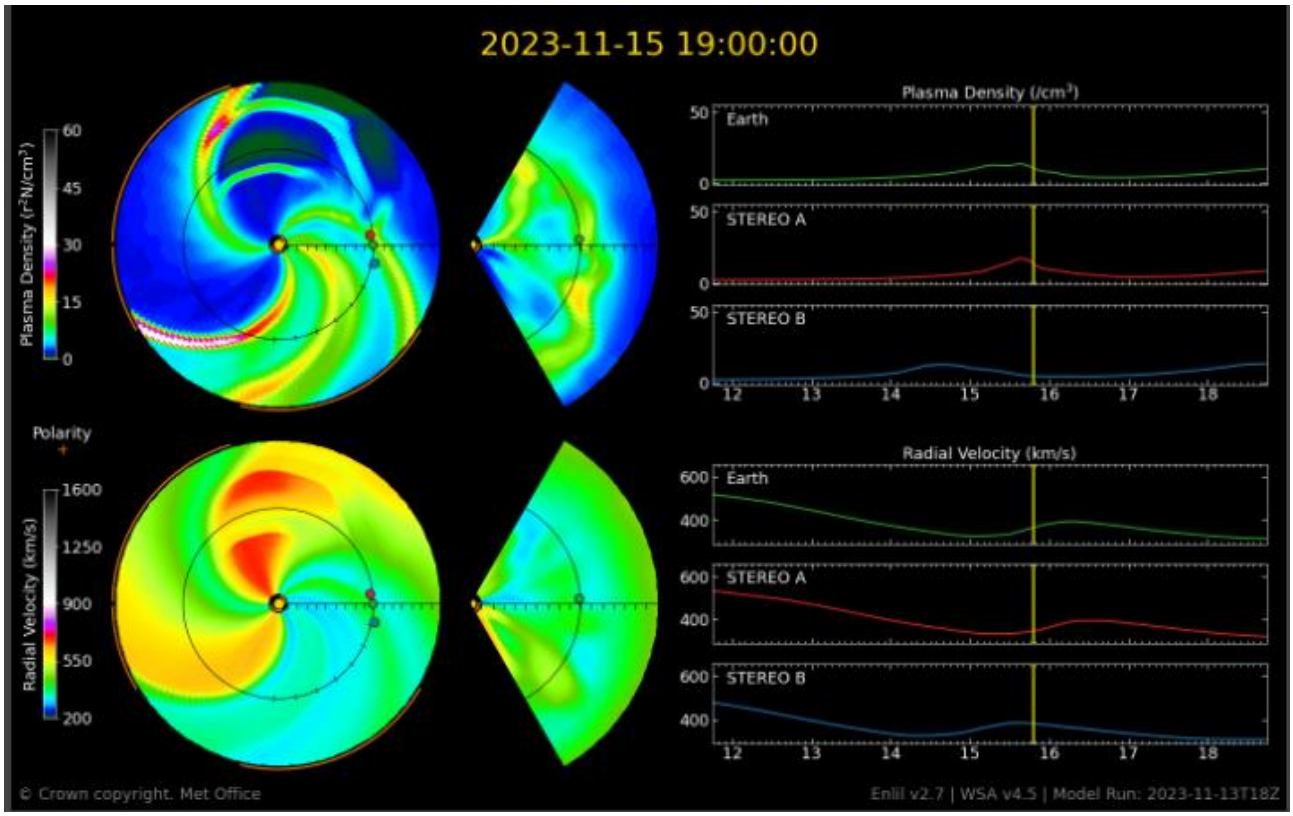
Figure 2: MOSWOC Enlil showing return to background winds and slight enhancement on 15 Nov.



Radio Blackouts - X-Ray Flares:

There are five sunspots currently on the visible solar disc, all of which are numbered and all of which lie on the western disc. The eastern hemisphere has several areas of plage, but without evidence of sunspots.

AR3483 (Dho/Beta) close to the northwestern limb is the largest region and remains one of the more complex regions on the disc. Newly numbered AR3487 (Dai/Beta), developed readily through 13 Nov and is now the most complex region on the disc. It has seen the proliferation of new intermediate spots and maturing of the penumbra on the trailing portion whilst also decreasing in longitudinal extent.
The remaining regions are all fairly small but have shown signs of growth and development over the past 24 hours and have some magnetic complexity, particularly AR3484 (Eao/Beta) and nearby region AR3485 (Dso/Beta-Gamma).

AR3483 and AR3484 should rotate beyond the western limb towards the end of Day 1 (14 Nov), with AR3485 by Day 3 (16 Nov). The viewing angle of these region will become increasingly limited as they approach the western limb with their classification likely to be maintained as they rotate off the disc. STEREO-EUVI ahead imagery shows areas of brightness beyond the eastern limb, far-sided soundings, persistence and flux looping all suggest limited contributions from any new or returning regions over the eastern limb during the period. The result is, that in the absence of significant sunspot development, the risk of M-class flares decreases towards the end of the period.

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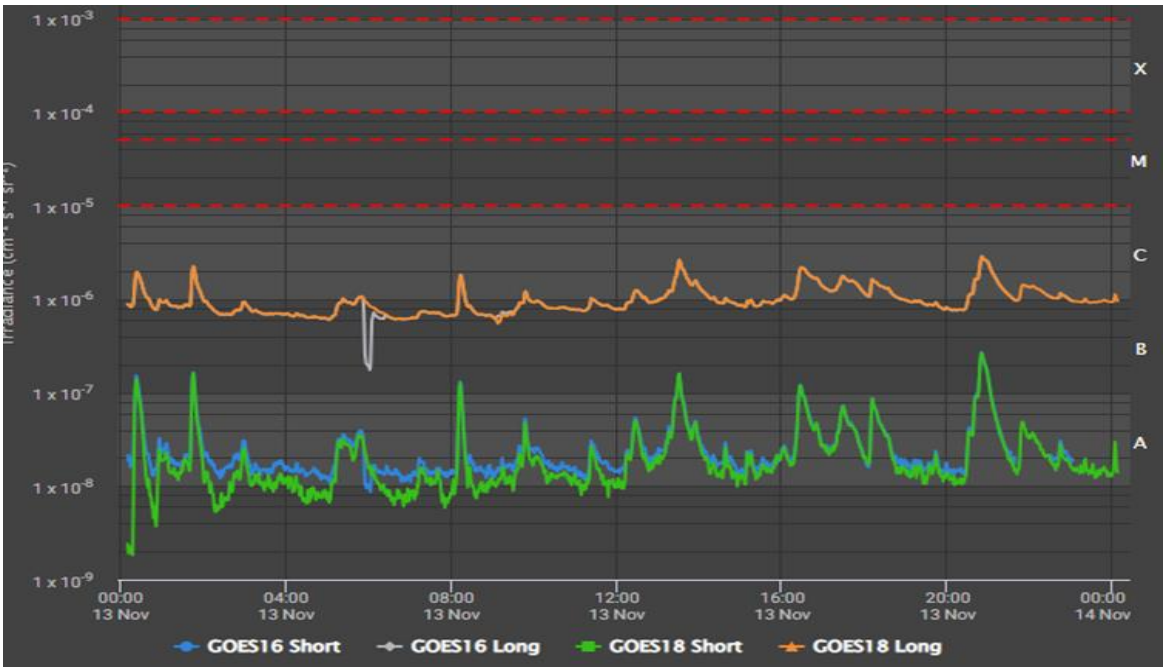
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	15	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES16 and GOES18 X-ray trace for past 24 hours



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels. The sunspots that are currently located in the western hemisphere pose a slight chance of producing S1/Minor Radiation Storm conditions during the period. Probabilities begin to wane later in the period as these regions rotate well beyond the western limb.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	2	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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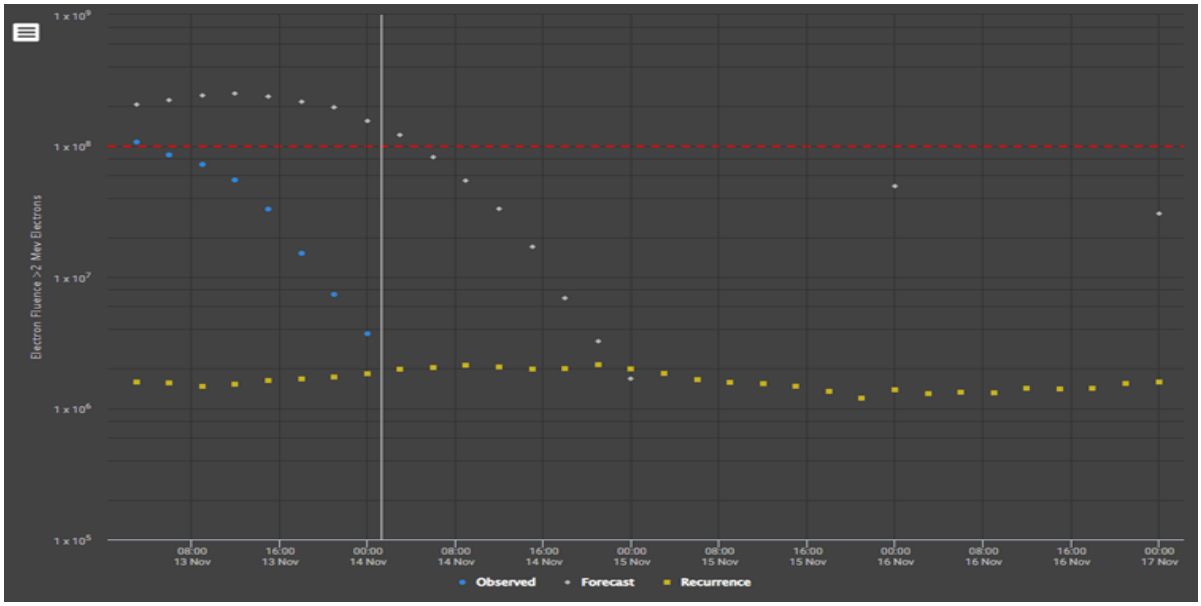
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at High levels over recent days in response to the fast wind from CH67/-. Following a CME arrival early on 12 Nov, observed flux levels fell to predominantly background levels around 13/0200 UTC. Further suppression of the electron belt may have transpired due to weak effects from CH68/+.

There is low confidence in the behaviour of the electron flux in the coming days but we may see a relaxation of the radiation belt and an increase in the electron flux through Days 1-2 (14-15 Nov) which may then result in periods of High flux levels for the remainder of the period. The potential for further geomagnetic activity on Day 2 complicates the flux forecast.

Electron fluence is continues to decline, but may recover towards Active levels from Day 2 onwards in response to the forecast increased electron flux. Low confidence in the extent of any Active periods due to uncertainty in the electron flux and geomagnetic forecasts. MOSWOC REFM is suggesting an increase towards Active fluence Days 3-4 (16-17 Nov), but this may not take into account recovery of flux levels from their recent suppression. The trend of REFM is considered reasonable guidance, even if the timing of onset of any potential Active fluence periods is low confidence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	30	40	50	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM giving reasonable steer for trend of fluence. Low confidence in electron response to potential geomagnetic activity in the forecast.



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